CONTROLLED-RELEASE DEVICE FOR SOUTHERN PINE BEETLE BEHAVIORAL CHEMICALS[1]

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ABSTRACT

A device was developed for the controlled release of the southern pine beetle attractant frontalure. Devices with 2, 3, 4, 5 and 6mm openings were tested in both controlled and ambient environments. Elution devices with smallest openings had the lowest and most uniform release rates, while those with larger openings released pheromone more erratically.

Key Words: *Dendroctonus frontalis*, pheromone dispenser

INTRODUCTION

Controlled-release devices have been devloped for several insect behavioral chemicals, including some of those associated with the southern pine beetle, *Dendroctonus frontalis* Zimmerman (Coleoptera: Scolytidae) (Thomas *et al.* 1975; Payne *et al.* 1977; Gamill *et al.* 1978). However, a device was not readily available to elute needed amounts of the attractant frontalure (Vité 1970) that would enable us to conduct population disruption field tests in 1979. Therefore, we carried out the following study to arrive at a simple and efficient controlled-release device.

METHODS AND MATERIALS

The elution devices we constructed were variations of the design reported by Gamill *et al.* (1978). The devices were 1 dram (45X15mm) glass vials with

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hard plastic screw caps. Two Rizla® cigarette filters were inserted into each vial. The only variation between elution devices was the size hole drilled in the center of the cap (i.e., 2, 3, 4, 5 and 6mm holes). Eight hundred $\mu\ell$ of frontalure were added to each vial. Frontalure was a 1:2 ratio of frontalin (Kinzer *et al.* 1969) and *alpha*-pinene.

One set of nine vials that included all hole sizes was held in a climatic chamber maintained at 31 C and 40% RH. An identical set of vials was placed outside the laboratory, where they were exposed to ambient weather conditions. These vials were exposed to direct sunlight only during mid-morning hours and were partially sheltered from rain. Two vials of each hole size were tested for each of the two experimental conditions. Exceptions were for the 2mm hole in the controlled (laboratory) set and the 6mm hole in the ambinet (outside) set, where only one device was used. All vials were placed horizontally. This essentially prevented precipitation from entering the vial in the set placed outside.

Elution rates were measured gravimetrically on a Mettler® H2O balance. Measurements were made daily from late August through October, 1979. Daily rainfall, minimum and maximum temperature, and hourly barometric pressure readings were obtained from nearby Easterwood Airport in College Station. Correlation analyses were performed between elution rates and each of these parameters.

RESULTS AND DISCUSSION

Hole size was directly proportional to release rate (Table 1) and inversely proportional to length of time the devices remained effective (Figures 1 and 2). There was a positive correlation between hole size and the degree of variability in elution rate. This was true for dispensers kept both inside and outside, although those kept outside generally displayed more variability in the rate of elution (Table 1). Under both controlled and ambient conditions, dispensers with the smallest hole sizes showed the most uniform elution rates over the longest time span (Figures 1 and 2). All dispensers under the controlled conditions showed an initial burst of frontalure release in the first day, and a subsequent dip in the rate of release in day 2 (Figure 1). The magnitude of these fluctuations was dependent upon hole size. Dispensers exposed to the ambient conditions also exhibited an initial adjustment period but to a lesser degree than those kept under controlled conditions (Figure 2).

During the course of the study, it was noticed that as the filters became dry they tended to absorb moisture; when this occurred, the devices often registered a gain in weight rather than a loss. This was true most commonly with those dispensers kept outside but also was found to some extent with those dispensers kept in the climatic chamber. Absorption and subsequent release of moisture likely caused inaccurate weight measurements for dispensers in which frontalure was nearly exhausted. As a result, measurements of dispenser weight loss became less dependable when most of the pheromone had dissipated.

The tendency for absorbent materials to retain moisture from the air, especially during periods of high humidity, is why we chose not to use cork stoppers as did Gammill *et al.* (1978). Also, as cork stoppers collect moisture

Table 1. – Mean elution rate (milligrams per day) of frontalure for period where rate is unaffected by exhaustion of chemical. Values are $\bar{X} \pm$ SD (n).

OPENING SIZE	UNDER CONTROLLED CONDITIONS	UNDER AMBIENT WEATHER CONDITIONS
2mm	18.38 ± 4.14 (27)	16.70 ± 4.50 (15)
3mm	29.61 ± 6.57 (22)	26.15 ± 8.03 (18)
4mm	45.16 ± 8.28 (15)	35.53 ± 9.44 (17)
5mm	49.39 ± 12.68 (14)	47.62 ± 16.49 (15)
6mm	77.81 ± 14.61 (8)	69.09 ± 13.74 (10)

they swell and thus alter the hole size and subsequently the elution rate. We found that corks not only absorb moisture from the air but also tend to absorb pheromone from inside the dispenser.

We were concerned with the effect of weather conditions on elution rate only for that period of time when the rate was not affected by exhaustion of frontalure. Therefore, Pearson product-moment and Spearman rank correlation analyses were performed on data prior to a sustained 50% decrease in elution rate. No significant correlation at the 5% level was found between elution rate and either maximum temperature, minimum temperature, difference in temperature (Tmax - Tmin) or rainfall. Maximum temperature averaged 88 F±3.5SD while mean minimum temperature was 68 F±6SD. Rainfall totalled only 1.1cm over the entire period in which analyses were performed. Although there was no significant correlation between elution rate and barometric pressure, there was an inverse relationship between these two factors, which would be expected. Dispensers with larger openings were more strongly correlated with pressure than those with smaller openings. Lack of significant correlation in thse parameters may in part be due to the relatively low N

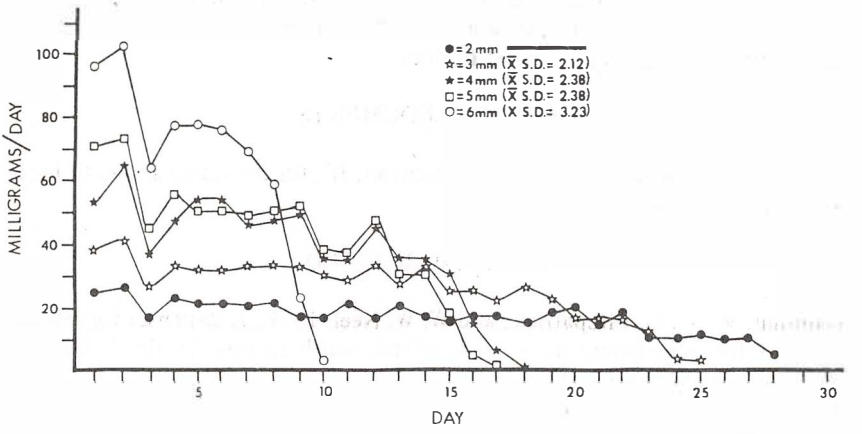

Fig. 1. – Mean daily elution rates of frontalure from dispensers with different size openings under controlled (laboratory) conditions.

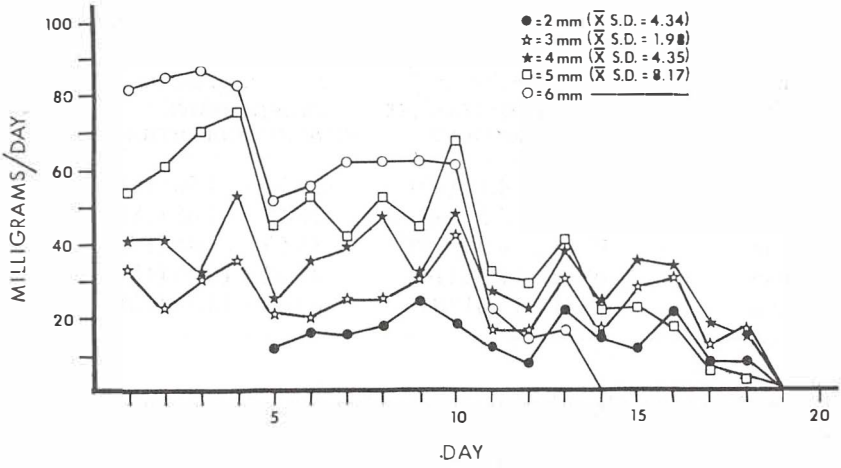

Fig. 2. – Mean daily elution rate of frontalure from dispensers with different size openings under ambient conditions (outdoor).

values (10-18); correlation coefficients themselves were relatively high, with many greater than 0.40. Two factors which may effect elution rate, air flow and humidity, were not measured. We suggest that subsequent attempts to determine the influence of environmental factors on elution rate be performed with devices filled with sufficient chemical to last many days longer than those reported here.

Our own research on the use of frontalure in the disruption of southern pine beetle infestations required an elution rate of ca. 72mg/tree/day (Richerson *et al.* 1980). As a result of this study, we determined that placement on each tree of two dispensers with 4mm openings was the best combination for our purposes. This combination offered a compromise between the high variability and short life span of a single 6mm device and the increased expense and labor requirements in assembly, installation and removal of four of the 2mm devices or three of the 3mm devices.

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Key Words: Sugarcane borer, *Apanteles flavipes* (Cameron), parasitism of sugarcane borers, food consumption by sugarcane borers, food utilization by sugarcane borers

Apanteles flavipes (Cameron) is a major gregarious larval endoparasite of graminaceous stem borers in the Far East and in Southeast Asia (Mohyuddin and Greathead 1970). It has recently been introduced and established in Florida, Texas, Brazil, Colombia, and Panama (Anonymous 1979) for biological control of the sugarcane borer (SCB), *Diatraea saccharalis* (F.).

We are interested in the possibility of periodically releasing *A. flavipes* in sufficient quantities to biologically control the SCB in sugarcane fields in Louisiana and Florida. However, with increased production of this parasite to implement these programs we needed information on how it affected host development, food consumption and utilization. We report herein results of experiments conducted to determine the effects of *A. flavipes* parasitization on food consumption and utilization by the host larva and the effects of host instar parasitized on length of parasite development.

MATERIALS AND METHODS

The parasites used in this study were initially collected from sugarcane fields at Canal Point, Florida, during the summer of 1978. The cocoons were placed in 12 x 14-cm plastic cages provided with three ventilation holes covered with nylon organdy. All cages were held at 26±1 C, 50±5% RH, with a 14:10LD cycle. The adults mated immediately upon emergence and were provided with honey and water. The colony was propagated by placement of one or two female parasites into a 22.5-ml plastic cup with two 4th-instar larvae feeding on a soyflour-wheat germ diet. Two weeks later, parasite cocoons were harvested from the cups and placed inside the plastic cages to repeat the cycle.

In test 1, host larvae were held individually in 22.5-ml plastic cups covered by plastic lids, fed a soyflour-wheat germ diet, and held at 26±1 C, 50±5% RH, with a 14L/10D cycle. One hundred larvae of each of five instars (day 2, 6, 9, 12, and 18 of the life cycle; confirmed by head capsule counts) (King *et al.* 1975) were exposed to 4-day-old female parasites (one parasite/host). As soon as one parasitization or "sting" was observed for each larva, the parasite was discarded and the host larva removed and placed onto preweighed diet. For each parasitized larva we determined total food consumption, parasite development period, numbers of parasites developing per host, and numbers of host larval head capsules shed after parasitization. Only data from hosts that actually produced parasites were used in statistical analyses. Also, comparable numbers of nonparasitized larvae in comparable stages of development were reared as controls. We obtained corrections for water evaporation by holding 100 uninfested cups under conditions identical to the experimental conditions, measuring weight loss, and conducting a least-squares linear regression as a function of the initial food weight.

In test 2, 100 15-day-old larvae of known weight were allowed to feed for